

that the return-air from the ventilating shaft of a mine may actually contain enough fire-damp to become inflammable when coal-dust is diffused into it. In the third he concludes that the influence of the coal-dust must not be considered as merely aggravating and increasing the explosion originating with the presence of fire-damp, but that the presence of the dust must be regarded as the one thing which, if a small explosion takes place anywhere, will accumulate and carry forward the force of the explosion with ever-increasing energy into every empty space in the workings, however ramified.

During the current year, experiments have also been made on the subject; at Harton Colliery (Durham) by Mr. Wood and Prof. Marreco, at Broad Oaks Iron-works by the Chesterfield Committee of Engineers, at Garswood Hall Colliery (Wigan), by Mr. Smethurst and the Royal Commission on Accidents in Mines, and lastly at Woolwich by Prof. Abel. The general character of the experiments has been on a plan originally devised by Mr. Galloway: viz. to expose to a flame, or to the flash of a small cannon, a stream of air in a miniature gallery into which any desired percentage of coal-gas or fire-damp was introduced, and into which coal-dust could be diffused by a hopper; arrangements also being made to raise the temperature of the gases, and to increase their velocity at will. The majority of the experimenters believe that in no case does a mixture of air and coal-dust *without fire-damp* explode, although the Chesterfield Committee think they have evidence that flame will travel in dust-laden air without a trace of fire-damp being present. This matter is of great importance, for it has been shown that in flour-mills explosions which have occurred may be traced to the presence of combustible dust in the air.

Prof. Abel had placed in his care thirteen samples of dust, some burnt, others unburnt—collected from different parts of the Seaham mine; which samples were subjected to careful examination in the microscope, and to chemical analysis. They were found to contain from 64.83 to 99.75 per cent. of pure coal-dust, some of them containing ash, grit, and fine sand in various proportions. They were then tested as to their power to aid in producing explosions in an experimental gallery. The gas employed was an explosive pit-gas, of such a quality that a mixture containing only 3.5 per cent. of the gas with air when travelling with a moderate velocity (from 200 to 1000 feet per minute) was ignited by the flame of a naked Davy lamp. In perfectly still air from 4 to 4.5 per cent. of the same gas was necessary to produce the same result. Currents of mixtures of this gas were conveyed into the experimental gallery at a velocity of 600 feet per minute, and at a temperature of 80° F.; a naked Davy lamp, its flame protected from the draught by a small screen, being placed in the gallery at about 12 feet from the place where the dust was supplied to the current. More and more fire-damp was gradually added until explosion took place; that dust being regarded as *most sensitive* which produced explosion with the least percentage of fire-damp. When the relative sensitiveness of the various samples of dust had thus been ascertained, it was found that, of the four which stood head of the list in point of sensitiveness, three headed the list also in point of richness in combustible matter and in point of fineness of texture. But the sample which stood third in point of sensitiveness was not only not the finest, but stood absolutely bottom of the list, in point of richness. It therefore appeared that porosity and mechanical condition are more important than combustibility of the dust in bringing about the ignition of a fully explosive gas. Prof. Abel was led, in consequence, to try whether the ignition of a mixture of air and fire-damp in a low percentage not inflammable of itself by contact with a lamp-flame could be brought about by the agency of a wholly incombustible dust. Accordingly dust such as calcined magnesia, pow-

dered chalk, and slate-dust was tried; and it was found that instantaneous explosion was thereby produced in currents of air containing only 3 to 3.5 per cent. of fire-damp. It appears then that *dust of any kind*, as a finely-divided solid, can operate in determining the explosion of an otherwise harmless mixture of gas and air; probably by furnishing, as the particles pass through the flame, successive red-hot nuclei, by which the heat is localised and rendered more intense.

In the special case of dust that is both fine and combustible, as coal-dust may be, it was proved that so small a proportion of fire-damp as 2 per cent. in moderate currents may determine the propagation of a flame by coal-dust. Now, as it is stated on the best authority that the most experienced eye cannot detect the presence of 2 per cent. of fire-damp by its effect on the flame of the ordinary Davy lamp; and as (in spite of all the host of little inventions to detect smaller percentages) the Davy lamp remains the only practical test of the presence or absence of fire-damp in fiery mines, it follows that, in every mine where there is any fire-damp *at all*, the mere dust of the mine constitutes an element of danger of which the risk is simply incalculable. When we add to this that experiments, made by firing such small blasts as eighty grains of gunpowder may represent, show that dust may cause the propagation of flame in air-currents containing percentages of fire-damp *far smaller than any* of those mentioned above, it is clear that whatever the risks with Davy lamps may be, they sink into insignificance beside the frightful dangers attending the firing of a shot for purposes of blasting. The practice of blasting the coal cannot be too emphatically condemned. It is at best a lazy and slovenly process of getting the coal, and considering the risks it entails, ought to be stringently and at once put down by legislation.

The practical moral is that, while the Davy lamp is to be regarded more than ever as a necessary of work in the pit, it cannot be regarded in any way as a safeguard of absolute kind against explosion; still less can it be regarded as an indicator of the presence or absence of impending danger, inasmuch as it is absolutely incompetent to detect such feeble percentages of gas as Prof. Abel has shown to be dangerous in the presence of the inevitable dust of the mine.

Science, which gave us the safety-lamp, must therefore be called upon once more to provide efficient substitutes. (1) A new lamp, electric or otherwise, must be devised, which shall be wholly independent of a supply of air from the galleries in which it is used; (2) an indicator must be invented to do what the Davy lamp fails to do, viz. to detect in the workings of the mine the presence of a proportion of fire-damp less than 2 per cent., and to indicate rapidly and accurately its amount. Let us hope that Prof. Abel will crown his labours by giving us such new instruments.

#### THE LANDSLIP AT ELM

THE Swiss papers contain valuable information as to the landslip which occurred on September 11 in the valley of the Sernft River, in the canton of Glarus. The month of September is notable in Switzerland for landslips. Thus the great landslip of the year 1618, which buried the whole of the town of Plurs in Graubünden, with its 2340 inhabitants, occurred on September 4; and the great downfall of the Rossberg Mountain, which destroyed the village of Goldau, with three other small villages, burying 111 houses and 457 persons, and filled up the Lake of Lowerz, occurred on September 2, 1807. The very heavy rains of the last few weeks have softened the rocks on the slopes of the Plattenberg Mountain, at the foot of which, at a height of 3330 feet, was situated the village of Elm, now almost completely destroyed by the landslip. The clay-slate quarries which were worked

upon the same slope have divided the masses of the rocks into large pieces, whilst the frequent earthquakes of the last months have given rise to large crevices in the slates and limestones. Already on September 9 it was perceived that the soil at the quarry was in slow motion, and a house situated immediately below was evacuated. Two days later, between five and six o'clock in the afternoon, it was seen that the forest on the slope of the mountain began to move, the trees being bent like a field of corn during a strong wind; they then rushed down, together with the rocks situated above the quarry, breaking up into thousands of pieces. This formidable stone avalanche reached the village, the trees were bent like straw, and the houses moved by the pressure of air pushed by the landslide. Men and houses were thrown on the opposite side of the valley, smashed against rocks, and buried by the landslide, which, as in the catastrophe of the Rossberg, crossed the valley and rose up-hill on its opposite side. The first landslide destroyed that part of the Elm Commune which is named Unterthal; but a second one followed immediately, destroying the village, and throwing the houses on the opposite side of the valley, one kilometre wide. The picturesque valley of Unterthal is now covered with a mass of mud, earth, and stones, thirty to forty metres thick, on the surface of which are seen blocks of the size of a house. The length of the landslide is about two kilometres, and the opposite side of the valley is covered with stones and blocks on a space of about 100 metres. The Sernft River, which flows in the valley, is barred by the *débris*, and has formed a small lake. The number of persons killed is about 160. Another small landslide occurred on the following day, and the slope of the mountain continues to be in motion. According to a report of Prof. Heim the remnant of the village is also threatened by a landslide, the Risikopf, or Grosskopf, being creviced and undergoing subsidences which render a landslide most probable, not so large, however, as the preceding one.

The *Times* Geneva correspondent writes under date September 19:—"According to the measurements and estimates of Prof. Heim, of Zurich University, who has just visited Elm, the earthslip of yesterday week, though less destructive of human life than the earthslip of Plurs and Goldau, probably exceeds in extent either of those catastrophes, great as they were. The portion of the Tschingel Alp which broke away from the parent mountain measured at its base 400 metres by 350 metres. The length of its projection outwards cannot, of course, now be ascertained. The length of what Prof. Heim calls the *débris* stream is 1500 metres, and varies in breadth from 300 to 400 metres. The distance of the extreme end of the stream from the place whence it broke away is 2000 metres. The extent of the valley bottom, which is tolerably even, covered by *débris* is computed at 570,000 metres, while the entire mass makes a total of 900,000 square metres. From the lower part of the valley to the upper joint of rupture the height is 620 metres. The fall was, therefore, a little over 2000 feet. The lowest estimate of the contents of the slip, according to the measurements of the engineers, is 10,000,000 cubic metres. It contains, says the Professor, enough stone to build two cities as large as Zurich, and the population of Zurich is 76,000. Some of the blocks, which are heaped 112 metres higher than the village of Elm, measure 1260 cubic metres, and are estimated to weigh 3300 tons. If the other earthslip, which is regarded as imminent, should take place, all that remains of Elm will be destroyed."

The heavy rains of the last weeks have caused several other landslips in Switzerland and Savoy. In the Upper Singine, in the canton of Freiburg, the soil is in slow motion in the valleys of the Gérine and Singine rivers, and a landslide of some importance has occurred at Planfayon. Another landslide occurred on September 2,

close by Bernex village, on the slope of the Dent d'Och, and it is rather remarkable by the circumstance that it occurred in a broad open valley where one never would suppose the possibility of a gliding of rocks.

A further interesting result of the recent heavy rains is that the Lake of Bicine, which is somewhat lower than that of Neuchâtel, is now so full that its water runs into the Lake of Neuchâtel, inundating its shores.

#### PHENOMENA DEVELOPED BY HELIOSTATIC STAR-DISKS

A HELIOSTAT of the highest class is doubtless beyond the means of ordinary observers, but such an instrument as the one now described is readily obtainable. Three sets of achromatic lenses forming a focal power of forty at ten inches, or a miniaturizing power of one-fortieth, are in general sufficient. If formed into a microscopic object-glass, the front is turned towards the sun. The glass then refracts a beautifully small star-disk, which, owing to the large angular aperture of the combination, remains steadily in view for several hours. The optical characters of this disk vary considerably with the quality of the lenses; practically a very fine one-quarter by Powell and Lealand produces disks of remarkable beauty and precision. In some cases a plane mirror is conveniently attached to reflect the oblique solar rays.

The instrument thus provides a stationary solar star-disk for continuous observation. No clockwork or machinery is required. The size of the disk is one-fourth of the sine of the solar diameter, or nearly 45-10,000ths of an inch.

A more brilliant form of surpassing effulgence is occasionally employed by a 3-inch lens placed before a right-angled prism. An aerial image of the sun thus produced outshines the electric light. These disks are viewed at a distance of ten feet.

It is proposed to describe first their use in microscopic research, and secondly for telescopic vision.

#### I. MICROSCOPIC RESEARCH

*The Miniature Method.*—A strong plate fitting the upper stage of the microscope by means of screws is pierced in the centre by an aperture carrying the "societies" standard screw, into which an objective can be firmly screwed. The stage motions then give readily the necessary adjustments for coincidence of optical axes. This is called the *stage-holder*. All previous methods of fixing the objective in the sub-stage have been abandoned; the necessary steadiness being almost unattainable.

*Phenomena of Heliostatic Star-Disks produced by the One-quarter.*—Stage-holder armed with an inverted 1-32nd water-immersion. The miniature of the star-disk is now viewed microscopically with a 1-16th immersion. When both of these objectives are adjusted for the most brilliant vision, *distant foliage is distinctly visible*. A flag-staff carrying the Union Jack 180 yards away displays its double cross. The fine lightning-rod surmounting it is distinctly visible. Houses on a hill glisten in the sunshine; but conspicuous above all is the minute solar star-disk blazing with all the glory of a midday Sirius at the open window-sill.

Here the favourite tests for telescopic precision come richly into play. A minute brilliant bead surrounded by the most intensely black ring—the more wonderful as the brilliance seems to heighten its rare and beautiful delicacy and blackness—comes up and plays into expanding coloured rings on each side of the principal focal point. (The delicate beauties of this exquisite phenomenon cannot well be seen without an exceedingly delicate fine focal adjustment.) The focussing wheel (constructed for the lightest contact) is divided into 132 parts; twenty-six give a focal plane the 1000th of an inch deeper or higher,